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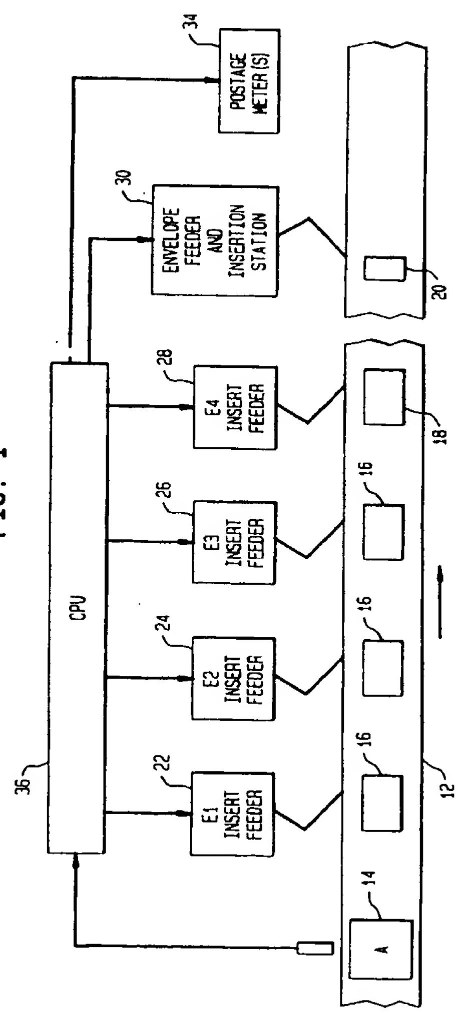
(54) **System and method for selecting optional inserts with optimal value in an inserting machine.**

(57) A method of making a selection of optional enclosures for a mailpiece including required enclosures. The method comprises the steps of assigning to each of the optional enclosures a weight, a cost and a benefit, creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures, computing a total weight of the mailpiece for each of the potential compositions, computing a value of the mailpiece for each of the potential compositions, the value being any computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions, and selecting from one of the potential compositions based on the one having the optimal value.

FIG. 1



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The invention disclosed herein relates generally to inserting machines, and more particularly to inserting machines capable of making an intelligent selection of enclosures.

Inserting machines with multi-feeder stations are widely utilized for mailing applications in which a plurality of different types of enclosures, such as account related documents, advertising enclosures or documents of general interest, are to be included with a customer's monthly statement. Examples of such applications are monthly statements mailed by utilities, credit card companies, and banking or other financial institutions. Included, typically, with the statement are one or more enclosures, or inserts, which may convey a message to the customers, such as an offer for additional services, a change in policy, or advertisements provided by third parties for inclusion within the monthly statement. Illustrative of such insertion machines are U.S. Patent Nos. 4,547,856, 4,077,181 and 3,935,429 which are assigned to the assignee of the present invention.

Early applications for inserting machines required that the insertion function be performed in accordance with a predetermined scheme that was fixed for each mailpiece being assembled. For example, in addition to the required statement and other required documents which must be inserted, such as paid bank checks, the inserting machines also insert a pre-specified number of enclosures. The pre-specified number may be programmed into the inserting machine or may be read from a control code printed on one of the required documents.

Although the inserting machines were well suited for such early applications, the market requirements evolved to demand inserting machines capable of making last minute decisions regarding which enclosures are to be included in a mailpiece and a required amount of postage for the mailpiece with the enclosures.

An application where this capability may prove especially advantageous concerns bank checking accounts wherein a variable number of documents expressive of a customer's monthly statement, a variable number of cancelled checks, and possibly one or more inserts of a general or advertising nature are required to be mailed. Due at least to the variation of the number of statement pages and cancelled checks between customers, the required postage for mailpieces produced will consequently vary over a wide range of postage values.

As is well known, the present postage rate categories for first-class letter mail are ultimately based on a final, total weight of a mailpiece. Therefore, any procedure for determining the correct amount of postage for a mailpiece must involve at some point in the procedure a weight-determining step.

The original way for performing such a weight-determining step comprised weighing the stuffed envelope. However, as inserting machine throughputs increased this technique of weighing each mailpiece became less practical, more complex and, hence, more expensive for the customer. Furthermore, such a weighing did not lend itself to supporting other advancements in inserting machine technology, such as a dynamic selection of inserts based on priority levels and/or the "topping off" of a mailpiece with additional inserts to take full advantage of a monetary value of a postage category for the mailpiece.

An alternate method to weighing a stuffed envelope is known to provide an inserting machine with a predetermined per item weight of the inserts held at each of a plurality of feeding stations and to store such per item weights in a data processing memory. A processing means, using the stored per item weights, calculates a total weight of each mailpiece based on the number of inserts selectively fed from the feeding stations. This calculated weight is then utilized to determine the postage category of the mailpiece. Thus, the inserting machine determines which one of a plurality of postage meters, each being set to apply postage relating to a different weight category, will be subsequently activated to apply postage to the mailpiece. Such a machine is disclosed in U.S. Patent No. 4,571,925 issued to Jerryl Adams. Once a postage category has been determined, it is known to utilize the calculated per item weight of the optional inserts in "topping off" a mailpiece by selectively feeding optional enclosures into a mailpiece without exceeding the postage category. Such a method is disclosed in U.S. Patents Nos. 4,639,873 and 4,797,830 issued to Baggarly et al. An alternate method of "topping off" is disclosed in U.S. Patent No. 4,821,493 issue to David Pintsov.

Although a "topping off" method may improve the value of the mailpiece, it does not necessarily achieve full value benefit of the postage category into which the mailpiece falls. Nor does "topping off" address a problem of the selection of enclosures for inserting based on criteria other than weight, such as demographic or other characteristics of the addressee. A method of prioritizing inserts based on criteria other than weight is disclosed in U.S. Patent No. 4,817,042 issued to Leon Pintsov. This method includes a final postage category determination based on the priority of the inserts which are selected for insertion into the mailpiece.

Thus, the multi-feeder station inserting machines have been utilized for applications which require the inserting machine to make intelligent decisions regarding which enclosures are to be included in a mailpiece. Usually these intelligent decisions are made during mailpiece assembly process and are based solely on the expected postage expense, i.e., cost, required for every mailpiece.

For every mailpiece to be assembled by the inserting machine there is a multiplicity of enclosures which fall into two general categories: 1) enclosures which must be included the mailpiece without any reservations, and 2) optional enclosures which may or may not be included.

Enclosures of the first category are usually financial statements, bills, checks and other personalized enclosures which constitute the mandatory content of the message being sent. These enclosures have a cost aspect associated with them which in the context of the present invention is the postage. This is the postage which would have to be paid based on the weight and the level of postal worksharing (presort and prebarcoding) associated with every given mailpiece. This postage also represents the minimal postage which would have to be paid for a given mailpiece.

Enclosures of the second category are usually of advertising or informational nature, which are included or not included into a given mailpiece depending on the potential increase in the postage cost which would have to be incurred, as in U.S. Patent No. 4,817,042, or only when no increase in postage would occur, as in U.S. Patent No. 4,639,873. The selection of the best alternative is based either on the total allowed increase in postage and after that the maximal number of enclosures (4,817,042) or just a maximal number of enclosures without increase in postage (4,639,873). In arriving at the decision inserting machines known in the prior art do not consider a total plurality of possible alternatives but rather sequentially evaluate enclosures for inclusion.

It is an aim of the present invention to provide a method for the selection of optional inserts whereby the optimal value, i.e., benefit, of each mailpiece is fully realized.

It is a general practice in economics and business daily life to make purchasing decisions based on the expected value which include both the cost and the benefit components of different available alternatives. The present invention attempts to overcome the deficiency in the prior art, where essentially purchasing decisions are made based on the cost or some other narrowly defined category, and formulates a very general and adaptive decision process which include as a very special cases previously suggested approaches.

The present invention provides a method for making a selection of optional enclosures for a mailpiece including required enclosures. The method comprises the steps of assigning to each of the optional enclosures a weight, a cost and a benefit, creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures, computing a total weight of the mailpiece for each of the potential compositions, computing a value of the mailpiece for each of the potential compositions, the value being a computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions. The final step is selecting the composition having the optimal value.

In one embodiment, the value could be the benefit minus the cost of each optional enclosure included in each of the potential compositions and minus the postage rate of each of the potential compositions. In another embodiment, the benefit could be a ratio of benefit to cost.

The invention will be better understood from the following non-limiting description of an example thereof given with reference to the accompanying drawings in which:-

Fig. 1 is a block diagram of an inserting machine having computer controlled selection of optional inserts in accordance with one example of the present invention;

Fig. 2 is a flow chart depicting a procedure for selecting optional inserts in accordance with the present invention; and

Fig. 3 is a flow chart depicting a procedure for determining an optimal composition of a mail run.

Referring now to Fig. 1, there is shown a portion of a multi-station inserting machine 10 including an embodiment of the present invention. In general, inserting machine 10 operates to feed documents from a plurality of document feeders, including insert feeders 22 through 28, onto a transport deck 12, the documents being accumulated into a collations 16 which are conveyed downstream on deck 12 to an envelope feeder and insertion station 30 where final collations 18 of the documents are inserted into an envelope to form a mailpiece 20. Thereafter, the envelope is sealed and conveyed to a postage meter 34 where a correct amount of postage is applied. The machine, in this illustrative embodiment, is operable for reading an indicia provided on a control document (shown as part of collation 14 of required documents for a mailpiece) which is also conveyed upon deck 12, the indicia being indicative, among other things, of which inserts from the plurality of insert feeders 22 through 28 are to be included within a particular envelope. Controlling the operation of insert feeders 22 through 28 in response to the indicia is a machine processing unit 36. The processing unit 36 is also operable for determining the correct amount of postage for each stuffed envelope and for providing by suitable communication means the postage information to postage meter 34. Meter 34 is comprised of a printer, such as an ink jet printer, operable for printing a postmark or postage indicia indicative of differing postage amounts upon each successive stuffed envelope depending on the weight of the stuffed envelope.

As previously noted, for every mailpiece to be assembled by the inserting machine there is a multiplicity of enclosures which fall into two general categories: 1) enclosures which must be included the mailpiece without any reservations, and 2) optional enclosures which may or may not be included.

In describing the preferred embodiment of the present invention, the following example will be used. The total assembly of enclosures which belong to the first category is denoted "A" (shown as collation 14 in Fig.

1) and there are four enclosures in the second category denoted El, E2, E3 and E4 (corresponding to insert feeders 22-28 in Fig. 1). The present invention can consider all possible combinations of enclosures for a given mailpiece. In the example used herein, all the potential combinations (all possible alternatives for composition of the mailpiece) are listed in Table I.

Table I

List of Possible Enclosure Combinations	
0.	A
1.	A + E1
2.	A + E2
3.	A + E3
4.	A + E4
5.	A + E1 + E2
6.	A + E1 + E3
7.	A + E1 + E4
8.	A + E2 + E3
9.	A + E2 + E4
10.	A + E3 + E4
11.	A + E1 + E2 + E3
12.	A + E1 + E2 + E4
13.	A + E1 + E3 + E4
14.	A + E2 + E3 + E4
15.	A + E1 + E2 + E3 + E4

The total number of combinations is 16. In the general case of "n" optional enclosures the total number of combinations is equal to:

$$\begin{bmatrix} n \\ o \end{bmatrix} + \begin{bmatrix} n \\ 1 \end{bmatrix} + \begin{bmatrix} n \\ 2 \end{bmatrix} + \begin{bmatrix} n \\ n \end{bmatrix} = 2^n$$

where [ ] denotes the number of ways to choose a k-element subset from an n-element set. In the case of n=5, the number of combinations is 32, and in the case of n=10, the number of combinations is 1024. The n=10 case covers a vast majority of the practically encountered situations. However, even for a larger n the number of combinations to be analyzed is quite manageable even for a modest modern microprocessor.

Which one of the combination alternatives is the "best" one? The answer to this question depends on a criterion for the best. If an objective numerically valued function "VALUE" can be defined on the set of all possible combinations then the maximal value of this function can define the best combination. In a particular embodiment the objective function "VALUE" can be defined as the difference (or the ratio or another function) between the total benefit and the total cost corresponding to a particular combination. The choice of a particular "VALUE" function depends on the considerations employed by the owner of the inserting system. For example, it may depend on the accounting system used by the owner. For the purpose of the present invention, this choice is irrelevant since the scheme described below will work equally as well with any "VALUE" function.

(It is assumed, of course, that the computational effort required for calculation of the "VALUE" function depends little on the actual nature of this function which is certainly true for all practical applications.) The total cost, which is the cost of postage and the cost of producing enclosures, can be determined based on the total weight of the mailpiece, worksharing level and the sum of enclosure costs.

In the example use herein, it is assumed, for the sake of simplicity, that the mailpiece to be assembled is not prebarcoded and not a member of presort group (i.e. it is not subject to a discount and will be paid at the full postage rate) and that the weights in ounces of assembly A and enclosures E1, E2, E3, E4 are as follows:

Weight (A) = 1.65
Weight (E1) = 0.2
Weight (E2) = 0.15
Weight (E3) = 0.1
Weight (E4) = 0.05

For the sake of simplicity, Weight (A) includes the weight of the mailing envelope.

It is also assumed that the cost of producing (or price paid for) each of enclosures E1, E2, E3, E4 are 2¢ , 2¢ , 3¢ , and 3¢ respectively. Then all the possible compositions of the mailpiece will have the incremental costs (i.e. the costs excluding the cost of making assembly A which is set to O) in 1992 U.S. postal rates listed in Table II.

Table II

Incremental Costs

O. Cost (A) = Postage (1.65 oz) = 52¢

1. Cost (A + E1) = 2¢ + Postage (1.85 oz) = 54¢

2. Cost (A + E2) = 2¢ + Postage (1.8 oz) = 54¢

3. Cost (A + E3) = 3¢ + Postage (1.75 oz) = 55¢

4. Cost (A + E4) = 3¢ + Postage (1.7 oz) = 55¢

5. Cost (A + E1 + E2) = 4¢ + Postage (2.0 oz) = 79¢

6. Cost (A + E1 + E3) = 5¢ + Postage (1.95 oz) = 57¢

7. Cost (A + E1 + E4) = 5¢ + Postage (1.9 oz) = 57¢

8. Cost (A + E2 + E3) = 5¢ + Postage (1.9 oz) = 57¢

9. Cost (A + E2 + E4) = 5¢ + Postage (1.85 oz) = 57¢

10. Cost (A + E3 + E4) = 6¢ + Postage (1.8 oz) = 58¢

11. Cost (A + E1 + E2 + E3) = 7¢ + Postage (2.1 oz) = 82¢

12. Cost (A + E1 + E2 + E4) = 7¢ + Postage (2.05 oz) = 82¢

13. Cost (A + E1 + E3 + E4) = 8¢ + Postage (2.0 oz) = 83¢

14. Cost (A + E2 + E3 + E4) = 8¢ + Postage (1.95 oz) = 60¢

15. Cost (A + E1 + E2 + E3 + E4) = 10¢ + Postage (2.15 oz) = 85¢

[Table II is based on the current rates in the USA. It can be easily changed to any other rate structure around the world. Also the worksharing option can be included without major complications.] It follows from the table that the minimal cost combination is the original assembly A without any optional enclosures. This is trivial and the least interesting case.

A "benefit function" is defined as follows. For purposes of describing the present invention, it will be assumed that each optional enclosure has a numerically valued benefit associated with it. For example, it can be an expected value of incremental business which the mail sender anticipates to generate as a result of inclusion of given inserts into an envelope. It can be determined, for instance, as the total incremental dollars generated as a result of the aggregate mailing divided by the number enclosures of a given type inserted in the mailing. For example, if as a result of sending 1,000 enclosures advertising sale of a piece of furniture the furniture store usually sells only one such a piece for $500, then the expected benefit of one advertising enclosure is $500/1,000 = 50¢. Of course, the furniture store would not pay 50¢ per piece but would have to consider some acceptable margin for profit, for instance 80%. In this case the furniture store would be willing to pay 10¢ per advertising enclosure and realize gross profit margin of $400. The scheme may be as complex as desired. For example, the results of advertising can be measure for two different mailings, one in 1,000 pieces and another in 10,000 pieces and the difference can be evaluated. The results can be measured and normalized or known statistics can be used. The demographic information can be easily taken into account in arriving at estimated benefits for optional enclosures. Moreover, if the demographic information is available to the control computer during the mail assembly process, e.g., via a control document, it can be used to modify benefits "on the fly".

Generally, there are well known methods for measuring effectiveness of direct mail advertising which include well defined and understood procedures. See, for example, The Dartnell DIRECT MAIL AND MAIL ORDER HANDBOOK, by R.S. Hodgson, Third Edition-1980, Appendix O.

It is assumed that the benefit of each of the enclosures E1, E2, E3, E4 are 60¢, 12¢,, 10¢ and 25¢ respectively. Then all the possible combinations will have the benefits listed in Table III. (The benefit of assembly A is set to 0 to simplify the description herein and the benefit is by definition an additive function to each of the combinations.)

Table III

Benefit of the Enclosures

0. Benefit (A) = 0
1. Benefit (A + E1) = 60¢
2. Benefit (A + E2) = 12¢
3. Benefit (A + E3) = 10¢
4. Benefit (A + E4) = 25¢
5. Benefit (A + E1 + E2) = 72¢
6. Benefit (A + E1 + E3) = 70¢
7. Benefit (A + E1 + E4) = 85¢
8. Benefit (A + E2 + E3) = 22¢

9. Benefit (A + E2 + E4) = 37¢
10. Benefit (A + E3 + E4) = 35¢
11. Benefit (A + E1 + E2 + E3) = 82¢
12. Benefit (A + E1 + E2 + E4) = 97¢
13. Benefit (A + E1 + E3 + E4) = 95¢
14. Benefit (A + E2 + E3 + E4) = 47¢
15. Benefit (A + E1 + E2 + E3 + E4) = 107¢

If the function VALUE defined as the difference between the benefit and the cost, then this results in Table IV.

Table IV
Value of the Enclosures

0. VALUE (A) = -52¢
1. VALUE (A + E1) = 6¢
2. VALUE (A + E2) = -42¢
3. VALUE (A + E3) = -45¢
4. VALUE (A + E4) = -30¢
5. VALUE (A + E1 + E2) = -7¢
6. VALUE (A + E1 + E3) = 13¢
7. VALUE (A + E1 + E4) = 28¢
8. VALUE (A + E2 + E3) = -35¢
9. VALUE (A + E2 + E4) = -20¢
10. VALUE (A + E3 + E4) = -23¢
11. VALUE (A + E1 + E2 + E3) = 0¢
12. VALUE (A + E1 + E2 + E4) = 15¢
13. VALUE (A + E1 + E3 + E4) = 12¢
14. VALUE (A + E2 + E3 + E4) = -13¢
15. VALUE (A + E1 + E2 + E3 + E4) = 22¢

It is clear from Table IV that the optimal value of 28¢ is found in line 7 which corresponds to the selection of enclosures E1 and E4. Thus, in this instance the present optional enclosures E1 and E4 will be selected for the mailpiece. This is different from the selection of optional inserts pursuant to a "topping off" method. According to a "topping off" method, for example as in U.S. Patent No. 4,639,873, inserts E2, E3 and E4 would be selected because the three optional inserts can be added to the mailpiece without exceeding the one ounce postage category of the mailpiece determined from the weight of the required enclosures W(A).

In general, the "topping off" method will produce the same results as the present invention only when the cost of material (Table II) and the benefit (Table III) is set to zero for all the optional enclosures. In such a case, the inserting machine cannot be operated to maximize the potential value of the mailpieces being assembled. Once cost and benefit are assigned to the optional enclosures an optimal value can be determined for each mailpiece, thus providing means for making an optimal selection of the optional inserts for each mailpiece.

Referring now to Fig. 2, there is provided a flowchart of an algorithm for computing optimal composition

of a mailpiece based on optimal value of optional inserts. The overall process of optimization proceeds as follows with n being the total number of optional enclosures. In the example described herein, n = 4 is the number of optional enclosures denoted by E1, E2, E3 and E4. At step 100, three numerical attributes, namely weight (w1, w2, ..., wn), cost (c1, c2, ..., cn) and expected benefit (b1, b2, ..., bn) for all optional enclosures are entered into an inserting machine control computer. The weight (wa) of the non-optional enclosures is also entered. R(W) is the rate function (or rate table) which defines the postage to be paid for the mailpiece with the weight W. If a change in the rate function is necessary, it is also entered. (It is noted that the expected benefit can be modified "on the fly" as described in U.S. Patent No. 4,817,042.) After the expected benefits for all optional enclosures are entered, at step 102 the control processor (36 in Fig. 1) determines all the potential compositions of the mailpiece to be assembled. At step 104, the control processor computes the total weight (W1, W2, ..., $W2^n$) for all the potential compositions of the mailpiece. It is noted that W1 denotes an empty set, i.e., a mailpiece without any optional enclosures. At step 106, the control processor computes a postage rate for each of the potential compositions. At step 108, the control processor computes the Value for each of the potential compositions. At step 110, the processor selects the maximal value from the list of values computed for potential compositions. Finally, at step 112, the processor sends control signals to the appropriate optional enclosure feeders to realize the maximal value for the mailpiece. The foregoing steps are repeated for every mailpiece.

As previously described, the total number of potential compositions is 2^n where "n" is the number of optional enclosures. Typically, the number of such enclosures is between 2 and 8 and therefore the total number of possible combinations is between 4 and 256. For each of the possible combinations, the function VALUE is computed and the maximal value (which always exists) is selected. Then the combination corresponding to this maximal value is selected and the control system of the inserting machine executes the actual assembly process.

As a practical matter, the benefit attributes of all optional enclosures are not always known and sometimes cannot be estimated. In this case, the unknown benefits can be set to zero or to reasonably small values and the method of the preferred embodiment. of the present invention will select the minimal postage assembly. If the inclusion of optional enclosures was paid for by a third party then the benefit for these enclosures can be set based on the amount paid per item and a known weight distribution of the intended mail run. In this case, the third party is assured that all the enclosures will be sent while the mailing party, i.e., the party which is providing the insertion and mailing service, will be able to minimize the total postage paid for the mailing.

The value based algorithm used in the present invention can be modified to accommodate sliding postal rates or any other arbitrarily complex postal rates as long as the postal rates are algorithmically computable based on the weight, worksharing or other desired attributes. The benefit value of the optional enclosure can be also set or modified by the control document or a control file for computerized data base driven inserting machines.

A very similar approach can be applied for optimization of the entire mail run. For example, if the entire mail run consists of 10,000 pieces and weight distribution of mandatory enclosures for all the mail pieces in the run is known <u>before</u> the process of actual mail assembly, i.e., insertion, sealing, postaging etc., takes place, one can define the value function for the entire run. This function would take into account the difference (or ratio or any arbitrary computable function) between the benefit and the cost for the entire mail run. Thus, the determination of whether to include or not a given enclosure is based not on the total value of the given mailpiece but on the values for all mailpieces. This, of course, requires a prior knowledge of the weight distribution of mandatory enclosures for all the mailpieces in the mail run.

Referring now to Fig. 3, there is provided a flowchart of an algorithm for determining the optimal composition of a mail run. The process of optimization of the mail run proceeds as follows with n being the total number of optional enclosures and m being the total number of mailpieces in the mail run. At step 200, three numerical attributes, namely weight (w1,w2, ..., wn), cost (c1, c2, ..., cn) and expected benefit (b1, b2, ..., bn) for all optional enclosures are entered into an inserting machine control computer. The weight (wa) of the non-optional enclosures is also entered. R(W) is the rate function (or rate table) which defines the postage to be paid for the mailpiece with the weight W. If a change in the rate function is necessary, it is also entered. After the expected benefits for all optional enclosures are entered, at step 202 the control processor (36 in Fig. 1) determines all the potential compositions of a mailpiece to be assembled. At step 204, the control processor computes the total weight (W1, W2, ..., $W2^n$) for all the potential compositions of the mailpiece. It is noted that W1 denotes an empty set, i.e., a mailpiece without any optional enclosures. At step 206, the control processor computes an array of postage rates ($R(wam + W2^n)$) for each of the potential compositions for each of the mailpieces in a mail run. At step 208, the control processor computes an array of all possible compositions of the mail run. Then, at step 210, the control processor computes a list of potential values of the mail run by computing a value for each of the potential combinations of mailpieces in the mail run by selecting one element

from each row in the array of possible compositions to compute a list of potential values of the mail run. The value function is shown as a general function of benefits, costs an postage rates F[b1,b2,...,bn,c1,c2,...,cn, R(wai+Wji)], such as the difference between benefit and cost as shown in Fig. 2. It will be appreciated that other functions, such as a ratio of benefit to cost may also be used. Finally, at step 112, the processor selects an optimal value from the list of values computed for potential compositions of the mail run.

While the present invention has been disclosed and described with reference to a single embodiment thereof, it will be apparent, as noted above that variations and modifications may be made therein.

Claims

1. A method of making a selection of optional enclosures for a mailpiece including required enclosures, comprising the steps of:
   assigning to each of the optional enclosures a weight, a cost and a benefit;
   creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures;
   computing a total weight of the mailpiece for each of the potential compositions;
   computing a value of the mailpiece for each of the potential compositions, the value being any computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions; and
   selecting from the potential compositions the one providing the optimal value.

2. A mailing system of the type having a processing unit operable for selecting individual ones of a plurality of enclosure feeding stations for feeding optional enclosures contained therein for insertion in a mailpiece, said system comprising
   means for entering enclosure related data into the processing unit, said data including a weight, a cost and a benefit for each type of the optional enclosures;
   means for creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures;
   means for computing a total weight of the mailpiece for each of the potential compositions;
   means for computing a value of the mailpiece for each of the potential compositions, the value being a computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions; and
   means for selecting from one of the potential compositions based on the one having the optimal value.

3. The system of claim 2 wherein the means for computing said value of the mailpiece includes subtracting the cost from the benefit of each optional enclosure included in each of the potential compositions.

4. A method of optimizing an entire mail run comprising the steps of:
   entering the weight of each of the non-optional enclosures;
   entering for each of the optional enclosures a weight, a cost and a benefit;
   creating a list of the potential compositions for each of the mailpieces in the mail run, the list including a total of 2^n combinations of the optional enclosures for each of the mailpieces, where n equals the number of optional enclosures;
   computing a total weight for each of the potential compositions for each of the mailpieces in the mail run;
   computing an array of postage entires including postage for each of the potential compositions for each of the mailpieces in the mail run;
   computing an array of all possible compositions of each mailpiece of the mail run;
   computing a list of potential values of the mail run by computing a value for each of the potential combinations of mailpieces in the mail run;
   selecting an optimal value from the list of values to determine an optimal composition of the mail run.

FIG. 1

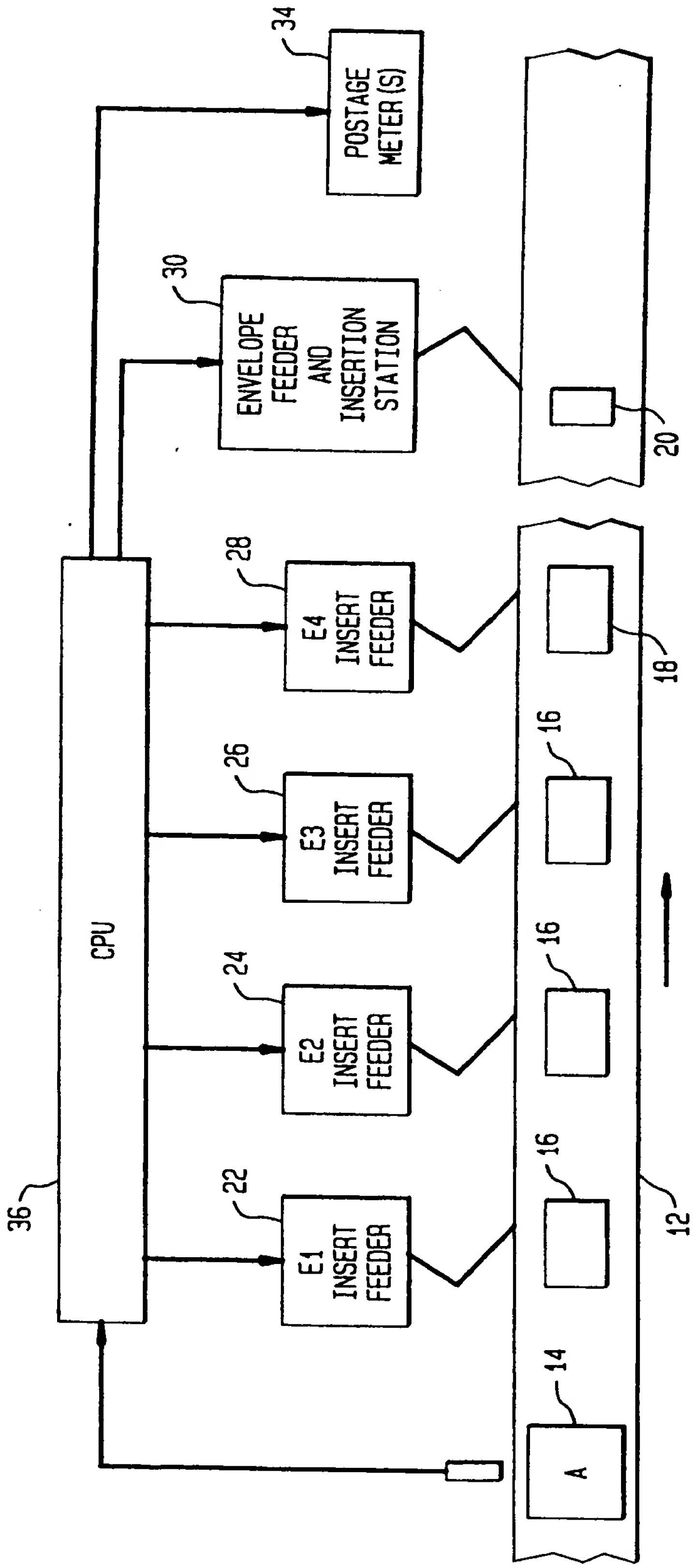

POSTAGE METER (S)
34
ENVELOPE FEEDER AND INSERTION STATION
30
20
CPU
36
E4 INSERT FEEDER
28
E3 INSERT FEEDER
26
E2 INSERT FEEDER
24
E1 INSERT FEEDER
22
18
16
16
16
14
A
12

FIG. 2

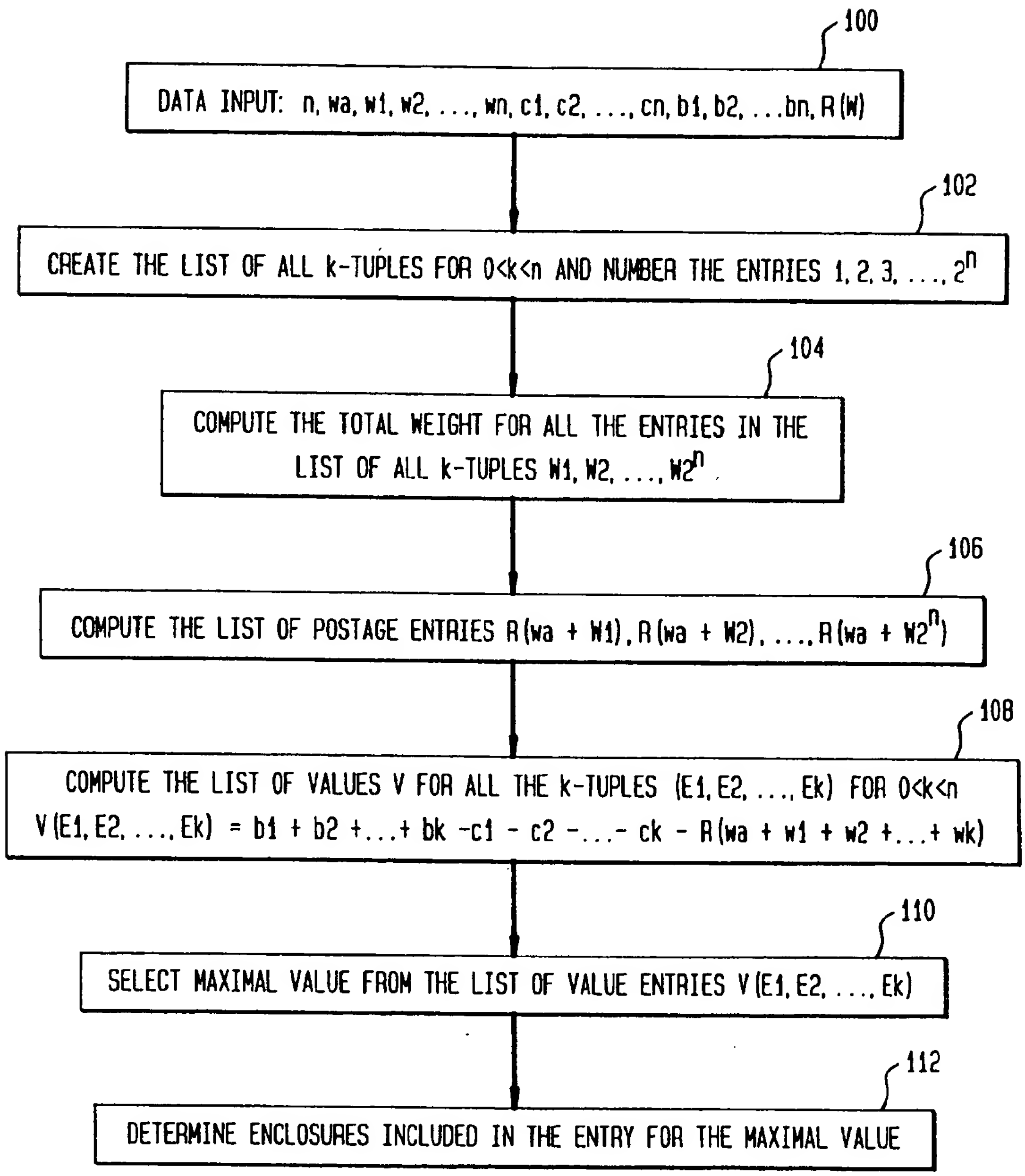
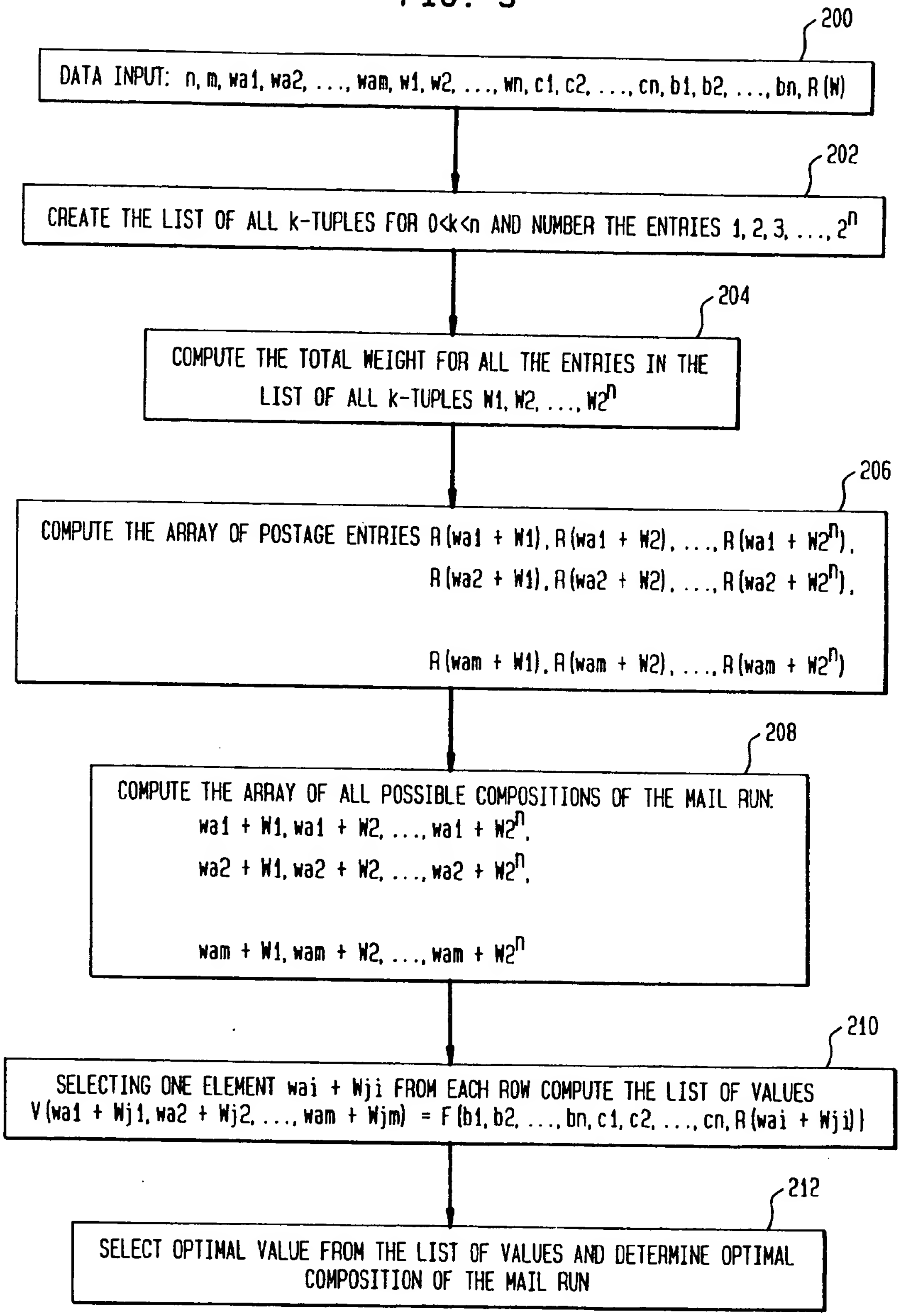

100
DATA INPUT: n, wa, w1, w2, . . ., wn, c1, c2, . . ., cn, b1, b2, . . .bn, R(W)
102
CREATE THE LIST OF ALL k-TUPLES FOR 0<k<n AND NUMBER THE ENTRIES 1, 2, 3, . . ., 2n
104
COMPUTE THE TOTAL WEIGHT FOR ALL THE ENTRIES IN THE LIST OF ALL k-TUPLES W1, W2, . . ., W2n
106
COMPUTE THE LIST OF POSTAGE ENTRIES R(wa + W1), R(wa + W2), . . ., R(wa + W2n)
108
COMPUTE THE LIST OF VALUES V FOR ALL THE k-TUPLES (E1, E2, . . ., Ek) FOR 0<k<n
V(E1, E2, . . ., Ek) = b1 + b2 +. . .+ bk -c1 - c2 -. . .- ck - R(wa + w1 + w2 +. . .+ wk)
110
SELECT MAXIMAL VALUE FROM THE LIST OF VALUE ENTRIES V(E1, E2, . . ., Ek)
112
DETERMINE ENCLOSURES INCLUDED IN THE ENTRY FOR THE MAXIMAL VALUE

FIG. 3


200
DATA INPUT: n, m, wa1, wa2, ..., wam, w1, w2, ..., wn, c1, c2, ..., cn, b1, b2, ..., bn, R(W)
202
CREATE THE LIST OF ALL k-TUPLES FOR 0<k<n AND NUMBER THE ENTRIES 1, 2, 3, ..., 2^n
204
COMPUTE THE TOTAL WEIGHT FOR ALL THE ENTRIES IN THE LIST OF ALL k-TUPLES W1, W2, ..., W2^n
206
COMPUTE THE ARRAY OF POSTAGE ENTRIES R(wa1 + W1), R(wa1 + W2), ..., R(wa1 + W2^n),
R(wa2 + W1), R(wa2 + W2), ..., R(wa2 + W2^n),
R(wam + W1), R(wam + W2), ..., R(wam + W2^n)
208
COMPUTE THE ARRAY OF ALL POSSIBLE COMPOSITIONS OF THE MAIL RUN:
wa1 + W1, wa1 + W2, ..., wa1 + W2^n,
wa2 + W1, wa2 + W2, ..., wa2 + W2^n,
wam + W1, wam + W2, ..., wam + W2^n
210
SELECTING ONE ELEMENT wai + Wji FROM EACH ROW COMPUTE THE LIST OF VALUES
V(wa1 + Wj1, wa2 + Wj2, ..., wam + Wjm) = F(b1, b2, ..., bn, c1, c2, ..., cn, R(wai + Wji))
212
SELECT OPTIMAL VALUE FROM THE LIST OF VALUES AND DETERMINE OPTIMAL COMPOSITION OF THE MAIL RUN

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(54) System and method for selecting optional inserts with optimal value in an inserting machine.

(57) A method of making a selection of optional enclosures for a mailpiece including required enclosures. The method comprises the steps of assigning to each of the optional enclosures a weight, a cost and a benefit, creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures, computing a total weight of the mailpiece for each of the potential compositions, computing a value of the mailpiece for each of the potential compositions, the value being any computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions, and selecting from one of the potential compositions based on the one having the optimal value.

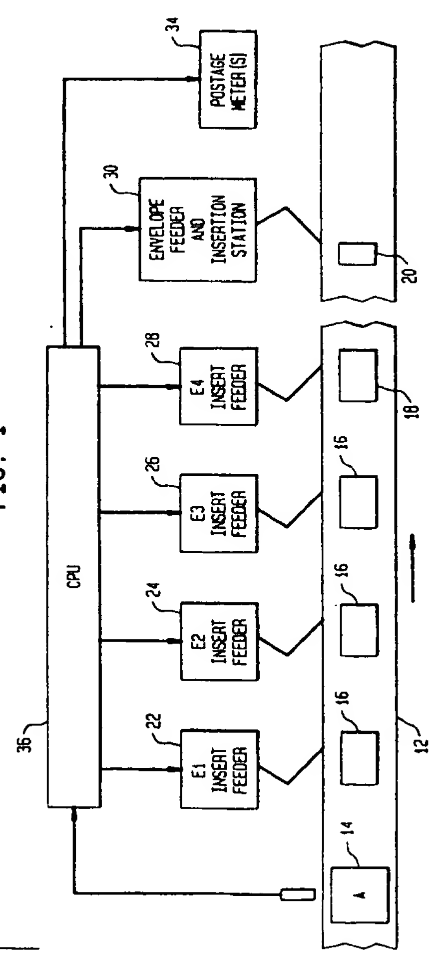

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 31 0184

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	US-A-4 829 443 (PINTSOV ET AL) * the whole document * -----	1,2,4	B07C1/00
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			B07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 December 1994	Forlen, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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(22) Date of filing: 16.12.1993

(54) System and method for selecting optional inserts with optimal value in an inserting machine

System und Verfahren zum Auswählen von wahlfreien Einlagen optimaler Geltung in einer Zufuhrmaschine

Système et procédé de sélection d'inserts optionnels de valeur optimale dans une machine d'insertion

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Description

The invention disclosed herein relates generally to inserting machines, and more particularly to inserting machines capable of making an intelligent selection of enclosures.

Inserting machines with multi-feeder stations are widely utilized for mailing applications in which a plurality of different types of enclosures, such as account related documents, advertising enclosures or documents of general interest, are to be included with a customer's monthly statement. Examples of such applications are monthly statements mailed by utilities, credit card companies, and banking or other financial institutions. Included, typically, with the statement are one or more enclosures, or inserts, which may convey a message to the customers, such as an offer for additional services, a change in policy, or advertisements provided by third parties for inclusion within the monthly statement. Illustrative of such insertion machines are U.S. Patent Nos. 4,547,856, 4,077,181 and 3,935,429 which are assigned to the assignee of the present invention.

Early applications for inserting machines required that the insertion function be performed in accordance with a predetermined scheme that was fixed for each mailpiece being assembled. For example, in addition to the required statement and other required documents which must be inserted, such as paid bank checks, the inserting machines also insert a pre-specified number of enclosures. The pre-specified number may be programmed into the inserting machine or may be read from a control code printed on one of the required documents.

Although the inserting machines were well suited for such early applications, the market requirements evolved to demand inserting machines capable of making last minute decisions regarding which enclosures are to be included in a mailpiece and a required amount of postage for the mailpiece with the enclosures.

An application where this capability may prove especially advantageous concerns bank checking accounts wherein a variable number of documents expressive of a customer's monthly statement, a variable number of cancelled checks, and possibly one or more inserts of a general or advertising nature are required to be mailed. Due at least to the variation of the number of statement pages and cancelled checks between customers, the required postage for mailpieces produced will consequently vary over a wide range of postage values.

As is well known, the present postage rate categories for first-class letter mail are ultimately based on a final, total weight of a mailpiece. Therefore, any procedure for determining the correct amount of postage for a mailpiece must involve at some point in the procedure a weight-determining step.

The original way for performing such a weight-determining step comprised weighing the stuffed envelope. However, as inserting machine throughputs increased this technique of weighing each mailpiece became less practical, more complex and, hence, more expensive for the customer. Furthermore, such a weighing did not lend itself to supporting other advancements in inserting machine technology, such as a dynamic selection of inserts based on priority levels and/or the "topping off" of a mailpiece with additional inserts to take full advantage of a monetary value of a postage category for the mailpiece.

An alternate method to weighing a stuffed envelope is known to provide an inserting machine with a predetermined per item weight of the inserts held at each of a plurality of feeding stations and to store such per item weights in a data processing memory. A processing means, using the stored per item weights, calculates a total weight of each mailpiece based on the number of inserts selectively fed from the feeding stations. This calculated weight is then utilized to determine the postage category of the mailpiece. Thus, the inserting machine determines which one of a plurality of postage meters, each being set to apply postage relating to a different weight category, will be subsequently activated to apply postage to the mailpiece. Such a machine is disclosed in U.S. Patent No. 4,571,925 issued to Jerryl Adams. Once a postage category has been determined, it is known to utilize the calculated per item weight of the optional inserts in "topping off" a mailpiece by selectively feeding optional enclosures into a mailpiece without exceeding the postage category. Such a method is disclosed in U.S. Patents Nos. 4,639,873 and 4,797,830 issued to Baggarly et al. An alternate method of "topping off" is disclosed in U.S. Patent No. 4,821,493 issue to David Pintsov.

Although a "topping off" method may improve the value of the mailpiece, it does not necessarily achieve full value benefit of the postage category into which the mailpiece falls. Nor does "topping off" address a problem of the selection of enclosures for inserting based on criteria other than weight, such as demographic or other characteristics of the addressee. A method of prioritizing inserts based on criteria other than weight is disclosed in U.S. Patent No. 4,817,042 issued to con Pintsov. This method includes a final postage category determination based on the priority of the inserts which are selected for insertion into the mailpiece.

Another method of prioritizing inserts is disclosed in U.S. Patent No. 4,829,443, which provides a table search technique which searches for and locates the value of postage in a predetermined table of postage values. The search is guided by information provided by a predetermined data key.

Thus, the presently-known multi-feeder station inserting machines have been utilized for applications which require the inserting machine to make intelligent decisions regarding which enclosures are to be included in a mailpiece. Usually these intelligent decisions are made during mailpiece assembly process and are based solely on the expected postage expense, i.e., cost, required for every mailpiece.

For every mailpiece to be assembled by the inserting machine there is a multiplicity of enclosures which fall into two

general categories: 1) enclosures which must be included the mailpiece without any reservations, and 2) optional enclosures which may or may not be included.

Enclosures of the first category are usually financial statements, bills, checks and other personalized enclosures which constitute the mandatory content of the message being sent. These enclosures have a cost aspect associated with them which in the context of the present invention is the postage. This is the postage which would have to be paid based on the weight and the level of postal worksharing (presort and prebarcoding) associated with every given mailpiece. This postage also represents the minimal postage which would have to be paid for a given mailpiece.

Enclosures of the second category are usually of advertising or informational nature, which are included or not included into a given mailpiece depending on the potential increase in the postage cost which would have to be incurred, as in U.S. Patent No. 4,817,042, or only when no increase in postage would occur, as in U.S. Patent No. 4,639,873. The selection of the best alternative is based either on the total allowed increase in postage and after that the maximal number of enclosures (4,817,042) or just a maximal number of enclosures without increase in postage (4,639,873). In arriving at the decision inserting machines known in the prior art do not consider a total plurality of possible alternatives but rather sequentially evaluate enclosures for inclusion.

It is an aim of the present invention to provide a method for the selection of optional inserts whereby the optimal value, i.e., benefit, of each mailpiece is fully realized.

It is a general practice in economics and business daily life to make purchasing decisions based on the expected value which include both the cost and the benefit components of different available alternatives. The present invention attempts to overcome the deficiency in the prior art, where essentially purchasing decisions are made based on the cost or some other narrowly defined category, and formulates a very general and adaptive decision process which includes as a very special case the previously suggested approaches.

The present invention is defined in the claims. In one embodiment, a method is used for making a selection of optional enclosures for a mailpiece including required enclosures. The method comprises the steps of assigning to each of the optional enclosures a weight, a cost and a benefit, creating a list of the potential compositions of the mailpiece, the list including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures, computing a total weight of the mailpiece for each of the potential compositions, computing a value of the mailpiece for each of the potential compositions, the value being a computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions. The final step is selecting the composition having the optimal value.

In one embodiment, the value could be the benefit minus the cost of each optional enclosure included in each of the potential compositions and minus the postage rate of each of the potential compositions. In another embodiment, the value could be a ratio of benefit to cost.

The invention will be better understood from the following non-limiting description of an example thereof given with reference to the accompanying drawings in which:-

Fig. 1 is a block diagram of an inserting machine having computer controlled selection of optional inserts in accordance with one example of the present invention;

Fig. 2 is a flow chart depicting a procedure for selecting optional inserts in accordance with the present invention; and

Fig. 3 is a flow chart depicting a procedure for determining an optimal composition of a mail run.

Referring now to Fig. 1, there is shown a portion of a multi-station inserting machine 10 including an embodiment of the present invention. In general, inserting machine 10 operates to feed documents from a plurality of document feeders, including insert feeders 22 through 28, onto a transport deck 12, the documents being accumulated into a collations 16 which are conveyed downstream on deck 12 to an envelope feeder and insertion station 30 where final collations 18 of the documents are inserted into an envelope to form a mailpiece 20. Thereafter, the envelope is sealed and conveyed to a postage meter 34 where a correct amount of postage is applied. The machine, in this illustrative embodiment, is operable for reading an indicia provided on a control document (shown as part of collation 14 of required documents for a mailpiece) which is also conveyed upon deck 12, the indicia being indicative, among other things, of which inserts from the plurality of insert feeders 22 through 28 are to be included within a particular envelope. Controlling the operation of insert feeders 22 through 28 in response to the indicia is a machine processing unit 36. The processing unit 36 is also operable for determining the correct amount of postage for each stuffed envelope and for providing by suitable communication means the postage information to postage meter 34. Meter 34 is comprised of a printer, such as an ink jet printer, operable for printing a postmark or postage indicia indicative of differing postage amounts upon each successive stuffed envelope depending on the weight of the stuffed envelope.

As previously noted, for every mailpiece to be assembled by the inserting machine there is a multiplicity of enclosures which fall into two general categories: 1) enclosures which must be included the mailpiece without any reservations, and 2) optional enclosures which may or may not be included.

In describing the preferred embodiment of the present invention, the following example will be used. The total

assembly of enclosures which belong to the first category is denoted "A" (shown as collation 14 in Fig. 1) and there are four enclosures in the second category denoted El, E2, E3 and E4 (corresponding to insert feeders 22-28 in Fig. 1). The present invention can consider all possible combinations of enclosures for a given mailpiece. In the example used herein, all the potential combinations (all possible alternatives for composition of the mailpiece) are listed in Table I.

Table I

List of Possible Enclosure Combinations	
0.	A
1.	A + E1
2.	A + E2
3.	A + E3
4.	A + E4
5.	A + E1 + E2
6.	A + E1 + E3
7.	A + E1 + E4
8.	A + E2 + E3
9.	A + E2 + E4
10.	A + E3 + E4
11.	A + E1 + E2 + E3
12.	A + El + E2 + E4
13.	A + El + E3 + E4
14.	A + E2 + E3 + E4
15.	A + E1 + E2 + E3 + E4

The total number of combinations is 16. In the general case of "n" optional enclosures the total number of combinations is equal to:

$$[^n{}_o] + [^n{}_1] + [^n{}_2] + [^n{}_n] = 2^n$$

where [ ] denotes the number of ways to choose a k-element subset from an n-element set. In the case of n=5, the number of combinations is 32, and in the case of n=10, the number of combinations is 1024. The n=10 case covers a vast majority of the practically encountered situations. However, even for a larger n the number of combinations to be analyzed is quite manageable even for a modest modern microprocessor.

Which one of the combination alternatives is the "best" one? The answer to this question depends on a criterion for the best. If an objective numerically valued function "VALUE" can be defined on the set of all possible combinations then the maximal value of this function can define the best combination. In a particular embodiment the objective function "VALUE" can be defined as the difference (or the ratio or another function) between the total benefit and the total cost corresponding to a particular combination. The choice of a particular "VALUE" function depends on the considerations employed by the owner of the inserting system. For example, it may depend on the accounting system used by the owner. For the purpose of the present invention, this choice is irrelevant since the scheme described below will work equally as well with any "VALUE" function. (It is assumed, of course, that the computational effort required for calculation of the "VALUE" function depends little on the actual nature of this function which is certainly true for all practical applications.) The total cost, which is the cost of postage and the cost of producing enclosures, can be determined based on the total weight of the mailpiece, worksharing level and the sum of enclosure costs.

In the example use herein, it is assumed, for the sake of simplicity, that the mailpiece to be assembled is not prebarcoded and not a member of presort group (i.e. it is not subject to a discount and will be paid at the full postage rate) and that the weights in ounces of assembly A and enclosures El, E2, E3, E4 are as follows:

Weight (A) = 1.65

Weight (El) = 0.2
Weight (E2) = 0.15
Weight (E3) = 0.1
Weight (E4) = 0.05

For the sake of simplicity, Weight (A) includes the weight of the mailing envelope.

It is also assumed that the cost of producing (or price paid for) each of enclosures El, E2, E3, E4 are 2¢, 2¢, 3¢, and 3¢ respectively. Then all the possible compositions of the mailpiece will have the incremental costs (i.e. the costs excluding the cost of making assembly A which is set to O) in 1992 U.S. postal rates listed in Table II.

Table II

Incremental Costs	
O.	Cost (A) = Postage (1.65 oz) = 52¢
1.	Cost (A + El) = 2¢ + Postage (1.85 oz) = 54¢
2.	Cost (A + E2) = 2¢ + Postage (1.8 oz) = 54¢
3.	Cost (A + E3) = 3¢ + Postage (1.75 oz) = 55¢
4.	Cost (A + E4) = 3¢ + Postage (1.7 oz) = 55¢
5.	Cost (A + E1 + E2) = 4¢ + Postage (2.0 oz) = 79¢
6.	Cost (A + E1 + E3) = 5¢ + Postage (1.95 oz) = 57¢
7.	Cost (A + E1 + E4) = 5¢ + Postage (1.9 oz) = 57¢
8.	Cost (A + E2 + E3) = 5¢ + Postage (1.9 oz) = 57¢
9.	Cost (A + E2 + E4) = 5¢ + Postage (1.85 oz) = 57¢
10.	Cost (A + E3 + E4) = 6¢ + Postage (1.8 oz) = 58¢
11.	Cost (A + E1 + E2 + E3) = 7¢ + Postage (2.1 oz) = 82¢
12.	Cost (A + E1 + E2 + E4) = 7¢ + Postage (2.05 oz) = 82¢
13.	Cost (A + E1 + E3 + E4) = 8¢ + Postage (2.0 oz) = 83¢
14.	Cost (A + E2 + E3 + E4) = 8¢ + Postage (1.95 oz) = 60¢
15.	Cost (A + E1 + E2 + E3 + E4) = 10¢ + Postage (2.15 oz) = 85¢

[Table II is based on the current rates in the USA. It can be easily changed to any other rate structure around the world. Also the worksharing option can be included without major complications.] It follows from the table that the minimal cost combination is the original assembly A without any optional enclosures. This is trivial and the least interesting case.

A "benefit function" is defined as follows. For purposes of describing the present invention, it will be assumed that each optional enclosure has a numerically valued benefit associated with it. For example, it can be an expected value of incremental business which the mail sender anticipates to generate as a result of inclusion of given inserts into an envelope. It can be determined, for instance, as the total incremental dollars generated as a result of the aggregate mailing divided by the number enclosures of a given type inserted in the mailing. For example, if as a result of sending 1,000 enclosures advertising sale of a piece of furniture the furniture store usually sells only one such a piece for $500, then the expected benefit of one advertising enclosure is $500/1,000 = 50¢. Of course, the furniture store would not pay 50¢ per piece but would have to consider some acceptable margin for profit, for instance 80%. In this case the furniture store would be willing to pay 10¢ per advertising enclosure and realize gross profit margin of $400. The scheme may be as complex as desired. For example, the results of advertising can be measure for two different mailings, one in 1,000 pieces and another in 10,000 pieces and the difference can be evaluated. The results can be measured and normalized or known statistics can be used. The demographic information can be easily taken into account in arriving at estimated benefits for optional enclosures. Moreover, if the demographic information is available to the control computer during the mail assembly process, e.g., via a control document, it can be used to modify benefits "on the fly".

Generally, there are well known methods for measuring effectiveness of direct mail advertising which include well defined and understood procedures. See, for example, The Dartnell DIRECT MAIL AND MAIL ORDER HANDBOOK,

by R.S. Hodgson, Third Edition-1980, Appendix O.

It is assumed that the benefit of each of the enclosures El, E2, E3, E4 are 60¢, 12¢, 10¢ and 25¢ respectively. Then all the possible combinations will have the benefits listed in Table III. (The benefit of assembly A is set to 0 to simplify the description herein and the benefit is by definition an additive function to each of the combinations.)

Table III

Benefit of the Enclosures	
O.	Benefit (A) = 0
1.	Benefit (A + El) = 60¢
2.	Benefit (A + E2) = 12¢
3.	Benefit (A + E3) = 10¢
4.	Benefit (A + E4) = 25¢
5.	Benefit (A + El + E2) = 72¢
6.	Benefit (A + El + E3) = 70¢
7.	Benefit (A + El + E4) = 85¢
8.	Benefit (A + E2 + E3) = 22¢
9.	Benefit (A + E2 + E4) = 37¢
10.	Benefit (A + E3 + E4) = 35¢
11.	Benefit (A + El + E2 + E3) = 82¢
12.	Benefit (A + El + E2 + E4) = 97¢
13.	Benefit (A + El + E3 + E4) = 95¢
14.	Benefit (A + E2 + E3 + E4) = 47¢
15.	Benefit (A + El + E2 + E3 + E4) = 107¢

If the function VALUE defined as the difference between the benefit and the cost, then this results in Table IV.

Table IV

Value of the Enclosures	
O.	VALUE (A) = -52¢
1.	VALUE (A + El) = 6¢
2.	VALUE (A + E2) = -42¢
3.	VALUE (A + E3) = -45¢
4.	VALUE (A + E4) = -30¢
5.	VALUE (A + E1 + E2) = -7¢
6.	VALUE (A + El + E3) = 13¢
7.	VALUE (A + El + E4) = 28¢
8.	VALUE (A + E2 + E3) = -35¢
9.	VALUE (A + E2 + E4) = -20¢
10.	VALUE (A + E3 + E4) = -23¢
11.	VALUE (A + El + E2 + E3) = 0¢
12.	VALUE (A + El + E2 + E4) = 15¢
13.	VALUE (A + El + E3 + E4) = 12¢
14.	VALUE (A + E2 + E3 + E4) = -13¢
15.	VALUE (A + El + E2 + E3 + E4) = 22¢

It is clear from Table IV that the optimal value of 28¢ is found in line 7 which corresponds to the selection of enclosures E1 and E4. Thus, in this instance the present optional enclosures E1 and E4 will be selected for the mailpiece. This is different from the selection of optional inserts pursuant to a "topping off" method. According to a "topping off" method, for example as in U.S. Patent No. 4,639,873, inserts E2, E3 and E4 would be selected because the three optional inserts can be added to the mailpiece without exceeding the one ounce postage category of the mailpiece determined from the weight of the required enclosures W(A).

In general, the "topping off" method will produce the same results as the present invention only when the cost of material (Table II) and the benefit (Table III) is set to zero for all the optional enclosures. In such a case, the inserting machine cannot be operated to maximize the potential value of the mailpieces being assembled. Once cost and benefit are assigned to the optional enclosures an optimal value can be determined for each mailpiece, thus providing means for making an optimal selection of the optional inserts for each mailpiece.

Referring now to Fig. 2, there is provided a flowchart of an algorithm for computing optimal composition of a mailpiece based on optimal value of optional inserts. The overall process of optimization proceeds as follows with n being the total number of optional enclosures. In the example described herein, n = 4 is the number of optional enclosures denoted by E1, E2, E3 and E4. At step 100, three numerical attributes, namely weight (w1, w2, ..., wn), cost (c1, c2, ..., cn) and expected benefit (b1, b2, ..., bn) for all optional enclosures are entered into an inserting machine control computer. The weight (wa) of the non-optional enclosures is also entered. R(W) is the rate function (or rate table) which defines the postage to be paid for the mailpiece with the weight W. If a change in the rate function is necessary, it is also entered. (It is noted that the expected benefit can be modified "on the fly" as described in U.S. Patent No. 4,817,042.) After the expected benefits for all optional enclosures are entered, at step 102 the control processor (36 in Fig. 1) determines all the potential compositions of the mailpiece to be assembled. At step 104, the control processor computes the total weight (W1, W2, ..., $W2^n$) for all the potential compositions of the mailpiece. It is noted that W1 denotes an empty set, i.e., a mailpiece without any optional enclosures. At step 106, the control processor computes a postage rate for each of the potential compositions. At step 108, the control processor computes the Value for each of the potential compositions. At step 110, the processor selects the maximal value from the list of values computed for potential compositions. Finally, at step 112, the processor sends control signals to the appropriate optional enclosure feeders to realize the maximal value for the mailpiece. The foregoing steps are repeated for every mailpiece.

As previously described, the total number of potential compositions is 2^n where "n" is the number of optional enclosures. Typically, the number of such enclosures is between 2 and 8 and therefore the total number of possible combi-

nations is between 4 and 256. For each of the possible combinations, the function VALUE is computed and the maximal value (which always exists) is selected. Then the combination corresponding to this maximal value is selected and the control system of the inserting machine executes the actual assembly process.

As a practical matter, the benefit attributes of all optional enclosures are not always known and sometimes cannot be estimated. In this case, the unknown benefits can be set to zero or to reasonably small values and the method of the preferred embodiment of the present invention will select the minimal postage assembly. If the inclusion of optional enclosures was paid for by a third party then the benefit for these enclosures can be set based on the amount paid per item and a known weight distribution of the intended mail run. In this case, the third party is assured that all the enclosures will be sent while the mailing party, i.e., the party which is providing the insertion and mailing service, will be able to minimize the total postage paid for the mailing.

The value based algorithm used in the present invention can be modified to accommodate sliding postal rates or any other arbitrarily complex postal rates as long as the postal rates are algorithmically computable based on the weight, worksharing or other desired attributes. The benefit value of the optional enclosure can be also set or modified by the control document or a control file for computerized data base driven inserting machines.

A very similar approach can be applied for optimization of the entire mail run. For example, if the entire mail run consists of 10,000 pieces and weight distribution of mandatory enclosures for all the mail pieces in the run is known <u>before</u> the process of actual mail assembly, i.e., insertion, sealing, postaging etc., takes place, one can define the value function for the entire run. This function would take into account the difference (or ratio or any arbitrary computable function) between the benefit and the cost for the entire mail run. Thus, the determination of whether to include or not a given enclosure is based not on the total value of the given mailpiece but on the values for all mailpieces. This, of course, requires a prior knowledge of the weight distribution of mandatory enclosures for all the mailpieces in the mail run.

Referring now to Fig. 3, there is provided a flowchart of an algorithm for determining the optimal composition of a mail run. The process of optimization of the mail run proceeds as follows with n being the total number of optional enclosures and m being the total number of mailpieces in the mail run. At step 200, three numerical attributes, namely weight (w1,w2, ..., wn), cost (c1, c2, ..., cn) and expected benefit (b1, b2, ..., bn) for all optional enclosures are entered into an inserting machine control computer. The weight (wa) of the non-optional enclosures is also entered. R(W) is the rate function (or rate table) which defines the postage to be paid for the mailpiece with the weight W. If a change in the rate function is necessary, it is also entered. After the expected benefits for all optional enclosures are entered, at step 202 the control processor (36 in Fig. 1) determines all the potential compositions of a mailpiece to be assembled. At step 204, the control processor computes the total weight (W1, W2, ..., $W2^n$) for all the potential compositions of the mailpiece. It is noted that W1 denotes an empty set, i.e., a mailpiece without any optional enclosures. At step 206, the control processor computes an array of postage rates ($R(wam + W2^n)$) for each of the potential compositions for each of the mailpieces in a mail run. At step 208, the control processor computes an array of all possible compositions of the mail run. Then, at step 210, the control processor computes a list of potential values of the mail run by computing a value for each of the potential combinations of mailpieces in the mail run by selecting one element from each row in the array of possible compositions to compute a list of potential values of the mail run. The value function is shown as a general function of benefits, costs an postage rates F[b1,b2,...,bn,c1,c2,...,cn, R(wai+Wji)], such as the difference between benefit and cost as shown in Fig. 2. It will be appreciated that other functions, such as a ratio of benefit to cost may also be used. Finally, at step 112, the processor selects an optimal value from the list of values computed for potential compositions of the mail run.

Claims

1. A method of making a selection of optional enclosures for a mailpiece, comprising the steps of:

   assigning to each of the optional enclosures a weight, a cost and a benefit;
   creating a list of potential compositions of the mailpiece, the potential compositions including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures;
   computing a total weight of the mailpiece for each of the potential compositions;
   computing an incremental cost of the mailpiece for each of the potential compositions, the incremental cost including a postage amount based on the total weight of the mailpiece for each of the potential compositions;
   computing a value of the mailpiece for each of the potential compositions, the value being a computable function of the benefit and the cost of each optional enclosure included in each of the potential compositions; and
   selecting from the potential compositions the one providing the optimal value to determine which of the optional enclosures are to be included in the mailpiece.

2. A method according to claim 1, wherein the step of computing the incremental cost comprises computing the cost by including the cost of each optional enclosure included in each of the potential compositions and a postage

amount based on the total weight of the mailpiece for each of the potential compositions, and wherein the step of computing said value comprises computing a function of the benefit and the incremental cost of each of the potential compositions.

3. A method according to claim 1 or 2, wherein the steps of creating said list, and computing the total weights, are performed in a processing means of a mailing system, the processing means being operable to selectively activate respective ones of a plurality of enclosure feeding stations to feed the selected optional enclosures for inclusion in the mailpiece.

4. A method according to claim 3, wherein the step of assigning weight, cost and benefit information for each optional enclosure comprises entering data indicative of the weight, cost and benefit into the processing means.

5. A method according to any preceding claim, further comprising using an inserter machine to assemble the mailpiece with the selected optional enclosures.

6. A mailing system of the type having processing means operable for selecting individual ones of a plurality of enclosure feeding stations for feeding optional enclosures contained therein for insertion in a mailpiece, said system comprising:

means for entering enclosure related data into the processing means, said data including a weight, a cost and a benefit for each type of the optional enclosures;
means for creating a list in the processing means of potential compositions of the mailpiece, the potential compositions including a total of 2^n combinations of the optional enclosures, where n equals the number of optional enclosures;
means for computing in the processing means a total weight of the mailpiece for each of the potential compositions;
means for computing in the processing means an incremental cost of the mailpiece for each of the potential compositions, said incremental cost including the cost of each optional enclosure included in each of the potential compositions and a postage amount based on the total weight of the mailpiece for each of the potential compositions;
means for computing in the processing means a value of the mailpiece for each of the potential compositions, the value being a computable function of the benefit and the incremental cost of each of the potential compositions; and
means for selecting from one of the potential compositions based on the one having an optimal value, wherein the individual ones of the plurality of enclosure feeding stations are selected based on the selected one of the potential compositions.

7. A system according to claim 6, wherein the means for computing said value of the mailpiece comprises means for subtracting the cost from the benefit of each optional enclosure included in each of the potential compositions.

8. A method of optimizing an entire mail run comprising the steps of:

entering the weight of each non-optional enclosure;
entering for each optional enclosure a weight, a cost and a benefit;
creating a list of the potential compositions for each of the mailpieces in the mail run, the potential compositions including a total of 2^n combinations of the optional enclosures for each of the mailpieces, where n equals the number of optional enclosures;
computing a total weight for each of the potential compositions for each of the mailpieces in the mail run;
computing an array of postage entries including postage for each of the potential compositions for each of the mailpieces in the mail run;
computing an array of all possible compositions of each mailpiece in the mail run;
computing a list of potential values of the mail run by computing a value for each of the potential combinations of mailpieces in the mail based on the benefit and cost of including the respective optional enclosures in each potential composition;
selecting an optimal value from the list of values to determine the selection of optional enclosures for each of the mailpieces of the mail run for providing an optimal composition of the mail run; and
using an inserting machine to assemble the mailpiece with the optional enclosures.

Patentansprüche

1. Verfahren zum Wählen von optionalen Anlagen für ein Poststück, umfassend die folgenden Schritte:

   Zuweisen eines Gewichts, von Kosten und eines Nutzens zu jeder der optionalen Anlagen;

   Erzeugen einer Liste von möglichen Zusammensetzungen des Poststücks, wobei die möglichen Zusammensetzungen insgesamt 2^n Kombinationen der optionalen Anlagen umfassen, wobei n der Anzahl von optionalen Anlagen gleicht;

   Berechnen eines Gesamtgewichts des Poststücks für jede der möglichen Zusammensetzungen;

   Berechnen von inkrementalen Kosten des Poststücks für jede der möglichen Zusammensetzungen, wobei die inkrementalen Kosten einen Portobetrag auf Grundlage des Gesamtgewichts des Poststücks für jede der möglichen Zusammensetzungen umfaßt;

   Berechnen eines Werts des Poststücks für jede der möglichen Zusammensetzungen, wobei der Wert eine berechenbare Funktion des Nutzens und der Kosten jeder optionalen Anlage, die in jeder der möglichen Zusammensetzungen enthalten ist, ist; und

   Wählen aus den möglichen Zusammensetzungen diejenige, die den optimalen Wert bereitstellt, um zu bestimmen, welche der optionalen Anlagen in das Poststück eingeschlossen werden soll.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Schritt einer Berechnung der inkrementalen Kosten eine Berechnung der Kosten durch Einschließung der Kosten jeder optionalen Anlage, die in jeder der möglichen Zusammensetzungen enthalten ist, und eines Portobetrags auf Grundlage des Gesamtgewichts des Poststücks für jede der möglichen Zusammensetzungen umfaßt, und daß der Schritt der Berechnung des Werts eine Berechnung einer Funktion des Nutzens und der inkrementalen Kosten von jeder der möglichen Zusammensetzungen umfaßt.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Schritte einer Erzeugung der Liste und einer Berechnung der Gesamtgewichte in einer Verarbeitungseinrichtung eines Versendesystems ausgeführt werden, wobei die Verarbeitungseinrichtung betreibbar ist, um selektiv jeweilige einer Vielzahl von Anlagen-Zuführungsstationen zu aktivieren, um die gewählten optionalen Anlagen für eine Einschließung in dem Poststück zuzuführen.

4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß der Schritt einer Zuweisung einer Gewichts-, Kosten- und Nutzeninformation für jede optionale Anlage ein Eingeben von Daten, die das Gewicht, die Kosten und den Nutzen darstellen, in die Verarbeitungseinrichtung umfaßt.

5. Verfahren nach irgendeinem vorangehenden Anspruch, ferner umfassend eine Verwendung einer Einfüger-Maschine, um das Poststück mit den gewählten optionalen Anlagen zusammenzusetzen.

6. Versendesystem des Typs, der eine Verarbeitungseinrichtung aufweist, die zum Wählen von einzelnen einer Vielzahl von Anlagen-Zuführungsstationen zum Zuführen von optionalen Anlagen, die darin zur Einfügung in ein Poststück enthalten sind, betreibbar ist, wobei das System umfaßt:

   eine Einrichtung zum Eingeben von Anlagen bezogenen Daten in die Verarbeitungseinrichtung, wobei die Daten ein Gewicht, Kosten und einen Nutzen für jeden Typ der optionalen Anlagen umfassen;

   eine Einrichtung zum Erzeugen einer Liste von möglichen Zusammensetzungen des Poststücks in der Verarbeitungseinrichtung, wobei die möglichen Zusammensetzungen insgesamt 2^n Kombinationen der optionalen Anlagen umfassen, wobei n der Anzahl von optionalen Anlagen gleicht;

   eine Einrichtung zum Berechnen eines Gesamtgewichts des Poststücks für jede der möglichen Zusammensetzungen in der Verarbeitungseinrichtung;

   eine Einrichtung zum Berechnen von inkrementalen Kosten des Poststücks für jede der möglichen Zusammensetzungen in der Verarbeitungseinrichtung, wobei die inkrementalen Kosten die Kosten jeder optionalen Anlage, die in jeder der möglichen Zusammensetzungen enthalten ist, und einen Portobetrag auf Grundlage des Gesamtgewichts des Poststücks für jede der möglichen Zusammensetzungen umfassen;

eine Einrichtung zum Berechnen eines Werts des Poststücks für jede der möglichen Zusammensetzungen in der Verarbeitungseinrichtung, wobei der Wert eine berechenbare Funktion des Nutzens und der inkrementalen Kosten jeder der möglichen Zusammensetzungen ist; und

eine Einrichtung zum Wählen einer der möglichen Zusammensetzungen auf Grundlage derjenigen, die einen optimalen Wert aufweist, wobei die einzelnen der Vielzahl von Anlagen-Zuführungsstationen auf Grundlage der gewählten einer der möglichen Zusammensetzungen gewählt werden.

7. System nach Anspruch 6, dadurch gekennzeichnet, daß die Einrichtung zum Berechnen des Werts des Poststücks eine Einrichtung zum Subtrahieren der Kosten von den Nutzen jeder optionalen Anlage, die in jeder der möglichen Zusammensetzungen enthalten ist, umfaßt.

8. Verfahren zum Optimieren eines gesamten Postlaufs, umfassend die folgenden Schritte:

Eingeben des Gewichts jeder nicht-optionalen Anlage;

Eingeben für jede optionale Anlage eines Gewichts, von Kosten und eines Nutzens;

Erzeugen einer Liste der möglichen Zusammensetzungen für jedes der Poststücke in dem Postlauf, wobei die möglichen Zusammensetzungen insgesamt 2^n Kombinationen der optionalen Anlagen für jedes der Poststücke umfaßt, wobei n der Anzahl von optionalen Anlagen gleicht;

Berechnen eines Gesamtgewichts für jede der möglichen Zusammensetzungen für jedes der Poststücke in dem Postlauf;

Berechnen einer Matrix von Portoeinträgen einschließlich eines Portos für jede der möglichen Zusammensetzungen für jedes der Poststücke in dem Postlauf;

Berechnen einer Matrix von allen möglichen Zusammensetzungen jedes Poststücks in dem Postlauf;

Berechnen einer Liste von möglichen Werten des Postlaufs durch Berechnen eines Werts für jede der möglichen Kombinationen von Poststücken in dem Postgut auf Grundlage der Nutzen und Kosten einer Einschließung der jeweiligen optionalen Anlagen in jeder möglichen Zusammensetzung;

Wählen eines optimalen Werts aus der Liste von Werten, um die Wahl der optionalen Anlagen für jedes der Poststücke des Postlaufs zu bestimmen, um eine optimale Zusammensetzung des Postlaufs bereitzustellen; und

Verwenden einer Einfügungs-Maschine, um das Poststück mit den optionalen Anlagen zusammenzusetzen.

Revendications

1. Procédé pour effectuer une sélection de pièces jointes optionnelles dans un envoi postal comprenant les étapes pour :

affecter à chacune des pièces jointes un poids, un coût et un bénéfice ;
créer une liste de compositions potentielles de l'envoi postal, les compositions potentielles incluant un total de 2^n combinaisons de pièces jointes optionnelles, où n est le nombre de pièces jointes optionnelles ;
calculer un poids total de l'envoi postal pour chacune des compositions potentielles ;
calculer une augmentation de coût de l'envoi postal pour chacune des compositions potentielles, l'augmentation de coût incluant un montant d'affranchissement basé sur le poids total de l'envoi postal pour chacune des compositions potentielles ;
calculer une valeur de l'envoi postal pour chacune des compositions potentielles, la valeur étant une fonction calculable du bénéfice et du coût de chaque pièce jointe optionnelle incluse dans chacune des compostions potentielles ; et
sélectionner parmi les compositions potentielles celle qui procure la valeur optimale pour déterminer laquelle (lesquelles) des pièces jointes optionnelles doit(doivent) être inclue(s) dans l'envoi postal.

2. Procédé selon la revendication 1, dans lequel l'étape pour calculer l'augmentation de coût comprend le calcul du

coût en incluant le coût de chaque pièce jointe optionnelle incluse dans chacune des compositions optionnelles et un montant d'affranchissement basé sur le poids total de l'envoi postal pour chacune des compositions potentielles, et dans lequel l'étape pour calculer ladite valeur comporte le calcul d'une fonction du bénéfice et de l'augmentation de coût de chacune des compositions potentielles.

3. Procédé selon la revendication 1 ou la revendication 2, dans lesquels les étapes pour créer une dite liste, et pour calculer les poids totaux, sont effectuées dans un moyen de traitement du système de courrier, le moyen de traitement pouvant être exploitable de manière à activer de manière sélective ceux respectifs parmi une pluralité de postes d'alimentation en pièces jointes pour qu'ils fournissent les pièces jointes optionnelles à inclure dans l'envoi postal.

4. Procédé selon la revendication 3, dans lequel l'étape pour affecter une information de poids, de coût et de bénéfice pour chaque pièce jointe optionnelle comporte l'entrée de données indiquant le poids, le coût et le bénéfice dans le moyen de traitement.

5. Procédé selon l'une quelconque des revendications précédentes, comprenant en outre l'utilisation d'une machine à insérer pour assembler l'envoi postal avec les pièces jointes optionnelles sélectionnées.

6. Système de courrier du genre possédant un moyen de traitement que l'on peut exploiter de manière à sélectionner les postes individuels parmi une pluralité de postes d'alimentation de manière à alimenter en pièces jointes optionnelles contenues dans ceux-ci pour insertion dans un envoi postal, ledit système comprenant :

   un moyen pour entrer des données relatives aux pièces jointes dans le moyen de traitement, lesdites données incluant un poids, un coût et un bénéfice pour chaque genre de pièce jointe optionnelle ;
   un moyen pour créer une liste dans le moyen de traitement de compositions potentielles de l'envoi postal, les compositions potentielles incluant un total de 2^n combinaisons de pièces jointes optionnelles, où n est le nombre de pièces jointes optionnelles ;
   un moyen pour calculer dans le moyen de traitement un poids total de l'envoi postal pour chacune des combinaisons potentielles ;
   un moyen pour calculer dans le moyen de traitement une augmentation du coût de l'envoi postal pour chacune des combinaisons potentielles, ladite augmentation de coût incluant le coût de chaque pièce jointe optionnelle incluse dans chacune des compositions potentielles et un montant d'affranchissement basé sur le poids total de chaque envoi postal pour chacune des compositions potentielles ;
   un moyen pour calculer dans le moyen de traitement une valeur de l'envoi postale pour chacune des compositions optionnelles, la valeur étant une fonction calculable du bénéfice et de l'augmentation du coût de chacune des compositions optionnelles ; et
   un moyen pour sélectionner à partir de l'une des compositions optionnelles sur la base de la composition particulière possédant une valeur optimale, dans lequel les postes d'alimentations individuels parmi une pluralité de postes d'alimentation en pièces jointes sont sélectionnés sur la base de la composition particulière sélectionnée parmi les compositions particulières.

7. Système selon la revendication 6, dans lequel le moyen pour calculer une dite valeur de l'envoi postal comprend un moyen pour soustraire le coût du bénéfice de chaque pièce jointe optionnelle incluse dans chacune des compositions optionnelles.

8. Procédé pour optimiser un lot complet de courrier comprenant les étapes pour :

   entrer le poids de chaque pièce jointe qui n'est pas optionnelle ;
   entrer, pour chaque pièce jointe optionnelle, un poids, un coût et un bénéfice ;
   créer une liste de compositions potentielles pour chacun des envois postaux constituant le lot de courrier, les compositions potentielles comprenant un total de 2^n combinaisons de pièces jointes optionnelles pour chacun des envois postaux, où n est égal au nombre de pièces jointes optionnelles ;
   calculer un poids total pour chacune des compositions potentielles pour chacun des envois postaux constituant le lot de courrier ;
   calculer une matrice d'entrées d'affranchissement en incluant un affranchissement pour chacune des compositions potentielles pour chacun des envois postaux constituant le lot de courrier ;
   calculer une matrice de toutes les combinaisons possibles de chaque envoi postal constituant le lot de courrier ;
   calculer une liste de valeurs potentielles du lot de courrier en calculant une valeur pour chacune des composi-

tions potentielles d'envois postaux du courrier sur la base du bénéfice et du coût de l'inclusion des pièces jointes optionnelles respectives dans chacune des compositions potentielles ;

sélectionner une valeur optimale dans la liste des valeurs pour déterminer la sélection de pièces jointes optionnelles pour chacun des envois postaux du lot de courrier pour fournir une composition optimale du lot de courrier ; et

utiliser une machine à insérer pour assembler l'envoi postal avec des pièces jointes optionnelles.

FIG. 1

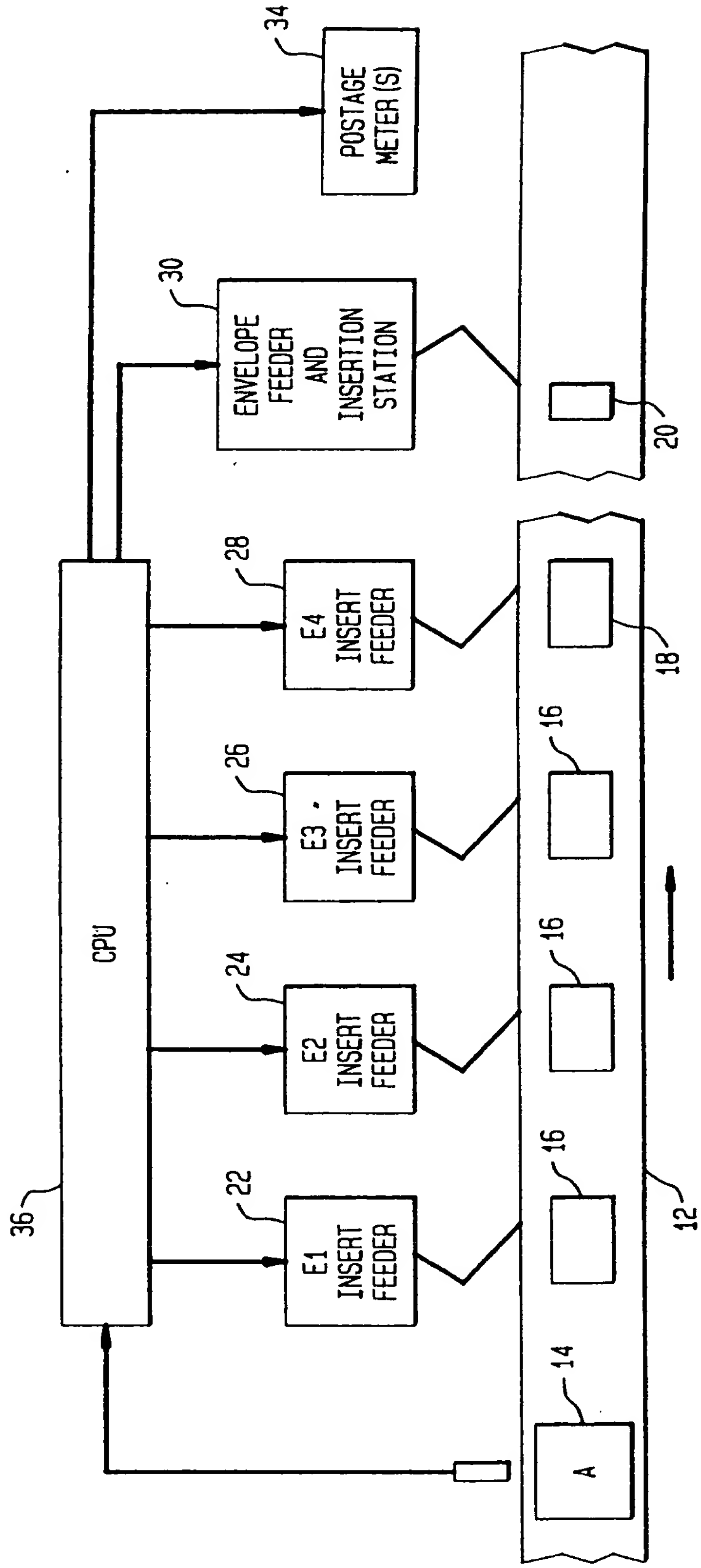

CPU
36
E1
INSERT
FEEDER
22
E2
INSERT
FEEDER
24
E3
INSERT
FEEDER
26
E4
INSERT
FEEDER
28
ENVELOPE
FEEDER
AND
INSERTION
STATION
30
POSTAGE
METER (S)
34
A
14
16
16
16
18
20
12

FIG. 2

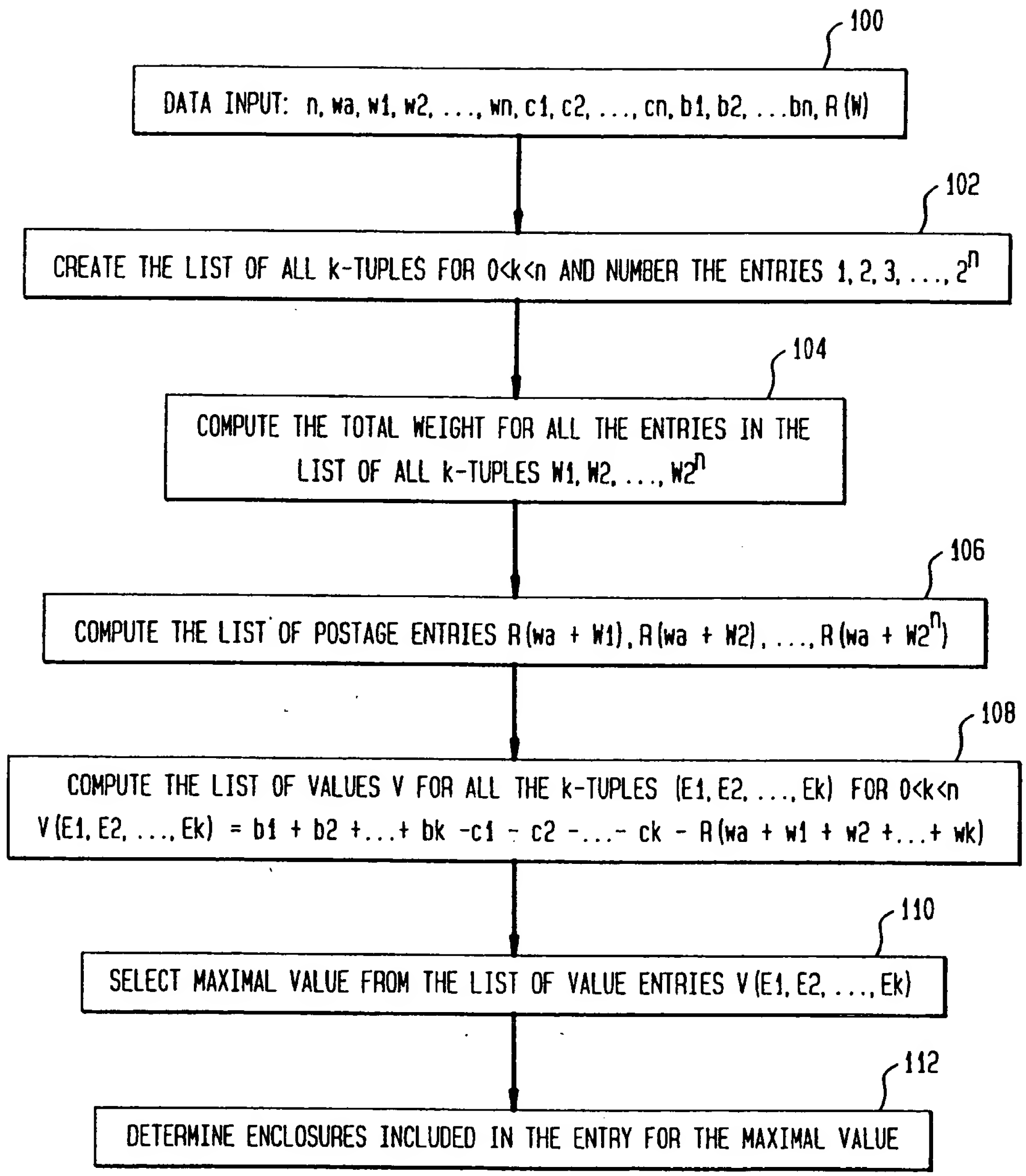
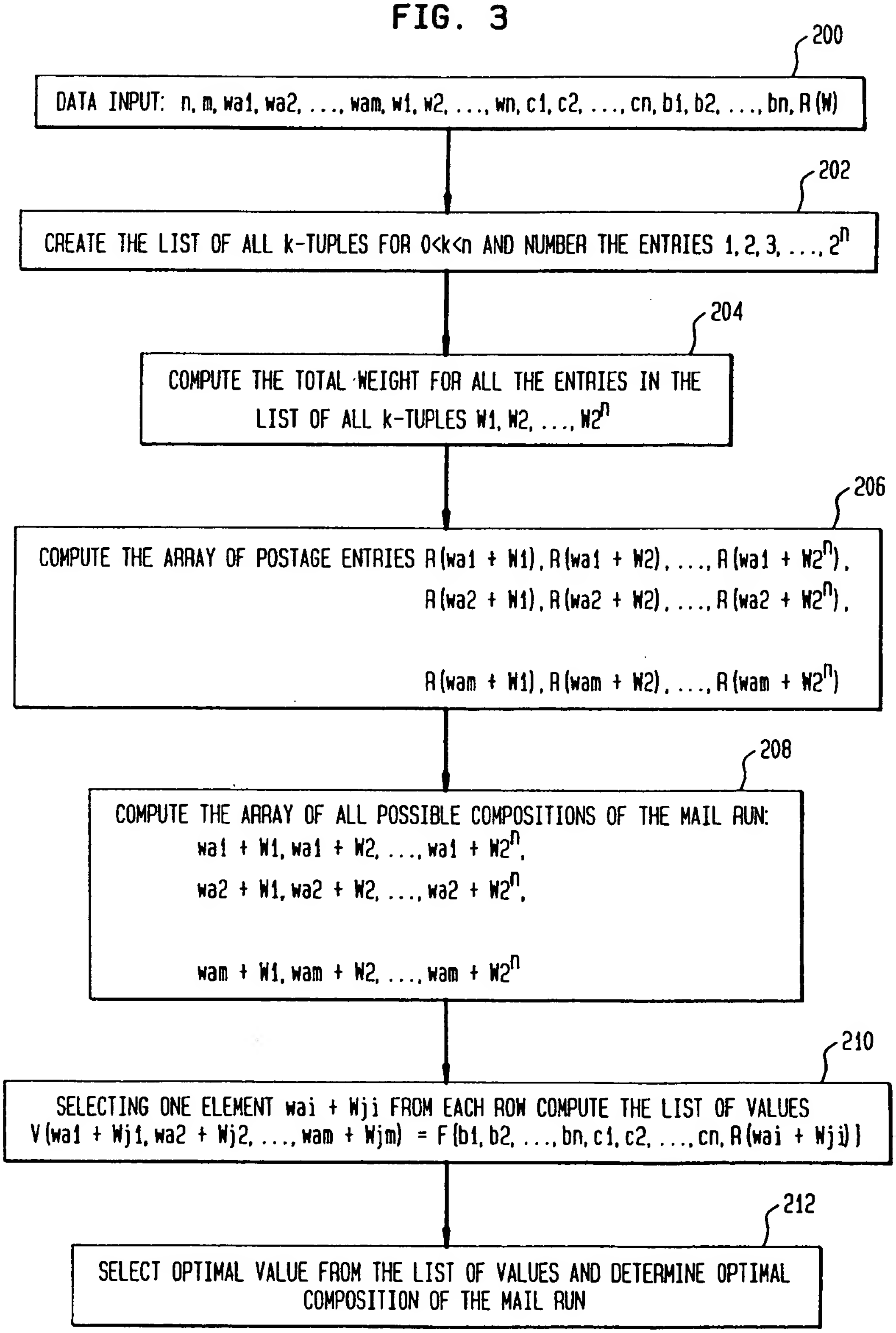

100
DATA INPUT: n, wa, w1, w2, . . ., wn, c1, c2, . . ., cn, b1, b2, . . .bn, R (W)
102
CREATE THE LIST OF ALL k-TUPLES FOR 0<k<n AND NUMBER THE ENTRIES 1, 2, 3, . . ., 2^n
104
COMPUTE THE TOTAL WEIGHT FOR ALL THE ENTRIES IN THE LIST OF ALL k-TUPLES W1, W2, . . ., $W2^n$
106
COMPUTE THE LIST OF POSTAGE ENTRIES R (wa + W1), R (wa + W2), . . ., R (wa + $W2^n$)
108
COMPUTE THE LIST OF VALUES V FOR ALL THE k-TUPLES (E1, E2, . . ., Ek) FOR 0<k<n
V (E1, E2, . . ., Ek) = b1 + b2 +. . .+ bk -c1 - c2 -. . .- ck - R (wa + w1 + w2 +. . .+ wk)
110
SELECT MAXIMAL VALUE FROM THE LIST OF VALUE ENTRIES V (E1, E2, . . ., Ek)
112
DETERMINE ENCLOSURES INCLUDED IN THE ENTRY FOR THE MAXIMAL VALUE

FIG. 3


200
DATA INPUT: n, m, wa1, wa2, ..., wam, w1, w2, ..., wn, c1, c2, ..., cn, b1, b2, ..., bn, R(W)
202
CREATE THE LIST OF ALL k-TUPLES FOR 0<k<n AND NUMBER THE ENTRIES 1, 2, 3, ..., 2^n
204
COMPUTE THE TOTAL WEIGHT FOR ALL THE ENTRIES IN THE LIST OF ALL k-TUPLES W1, W2, ..., W2^n
206
COMPUTE THE ARRAY OF POSTAGE ENTRIES R(wa1 + W1), R(wa1 + W2), ..., R(wa1 + W2^n),
R(wa2 + W1), R(wa2 + W2), ..., R(wa2 + W2^n),
R(wam + W1), R(wam + W2), ..., R(wam + W2^n)
208
COMPUTE THE ARRAY OF ALL POSSIBLE COMPOSITIONS OF THE MAIL RUN:
wa1 + W1, wa1 + W2, ..., wa1 + W2^n,
wa2 + W1, wa2 + W2, ..., wa2 + W2^n,
wam + W1, wam + W2, ..., wam + W2^n
210
SELECTING ONE ELEMENT wai + Wji FROM EACH ROW COMPUTE THE LIST OF VALUES
V(wa1 + Wj1, wa2 + Wj2, ..., wam + Wjm) = F(b1, b2, ..., bn, c1, c2, ..., cn, R(wai + Wji))
212
SELECT OPTIMAL VALUE FROM THE LIST OF VALUES AND DETERMINE OPTIMAL COMPOSITION OF THE MAIL RUN